NAVIGANT CONSULTING

Final Report

Independent Assessment of Stray Voltage in Underground Distribution Systems of Massachusetts Electric Companies

Submitted to

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Table of Contents

Overview

This report presents Navigant Consulting Inc.'s (NCI) assessment of stray voltage in underground distribution systems of the electric utilities under the jurisdiction of the Commonwealth of Massachusetts Department of Telecommunication & Energy (DTE). These utilities include:

1. NSTAR (Boston Edison Company, Cambridge Electric Light Company, and Commonwealth Electric Company);
2. National Grid (Massachusetts Electric Company and Nantucket Electric Company);
3. Northeast Utilities (Western Massachusetts Electric Company); and
4. Unitil (Fitchburg Gas & Electric Light Company)

NCI's report includes recommendations and responses to issues raised by the DTE in its Request for Responses (RFR). Our findings are based on information collected as of September 16, 2005. The report assesses the adequacy of the Massachusetts electric utilities' plans and procedures, and recommends additional action and remediation as warranted.

Background

Since early 2004, there have been several reported instances of animals and humans experiencing electrical shocks from equipment that normally is unenergized. The electrical shocks typically occur as a result of energized lines or equipment coming into full or partial contact with equipment or materials that are conducive to electric currents and elevated voltages. This phenomenon, commonly referred to as "Stray Voltage," has caused injuries to pets and the death of at least three dogs in Massachusetts. Other states, notably New York, have encountered similar stray voltage events, including the death of a woman in downtown Manhattan (Jodi Lane) in January 2004.[1]

[1] The New York Public Service Commission previously opened a proceeding to examine the safety of Consolidated Edison Company of New York, Inc.'s transmission and distribution systems. The NYPSC subsequently conducted an investigation of all jurisdictional utilities.

Following several stray voltage events in early 2004, the DTE directed electric utilities in Massachusetts under their jurisdiction to identify the extent to which stray voltage hazards exist in their respective service territories. Utilities were directed to inspect underground facilities and to report their findings, including plans for tracking, reporting and remediating stray voltage hazards, along with recommended underground inspection cycles. Shortly thereafter, the utilities inspected portions of their underground electric systems, from which they detected several instances of stray voltage on equipment they own, and on equipment and facilities owned by municipalities or private entities; for example, municipal-owned streetlights. Utilities reported that facilities and equipment where stray voltages were detected were immediately repaired; or soon thereafter if the level of stray voltage was deemed by the utility as not immediately harmful to workers or the general public.

Project Scope

NCI's assessment includes a review of the methods and practices employed or proposed by all electric utilities in Massachusetts under the DTE's jurisdiction:[2]

- NSTAR (Boston Edison Company, Cambridge Electric Light Company, and Commonwealth Electric Company);
- National Grid - (Massachusetts Electric Company and Nantucket Electric Company)
- Northeast Utilities (Western Massachusetts Electric Company)
- Unitil (Fitchburg Gas & Electric Light Company)

In an order issued January 5, 2005 and updated on July 21, 2005 on rehearing the NYPSC ordered New York utilities under their jurisdiction to implement formal stray voltage inspection programs, including annual voltage testing of all facilities capable of conducting electricity and that are accessible by the public. The order also requires utilities to inspect electric facilities on a 5-year basis, adopt safety inspection standards, certify inspection results and submit formal reports to the NYPSC. To ensure compliance, safety inspection rules include a performance mechanism that enables the NYPSC to penalize a utility up to 75 basis points (reduction) on its return on equity.

[2] Jurisdictional utilities include those that are investor-owned (IOU); municipal utilities are subject to limited DTE jurisdiction.

Collectively, these four companies serve approximately 90 percent of the total number of customers that receive electric service in Massachusetts. These utilities also own and operate many of the larger underground distribution systems in Massachusetts. Although NCI did not conduct an assessment of municipal systems, many of our findings, conclusions and recommendations also may apply to these companies. NCI also did not assess underground electric facilities owned by private entities; however, many of our findings and recommendations likely apply to facilities owned by third parties as well.

Our report addresses the following issues and questions raised by the DTE with respect to utility practices and procedures:

1. Adequacy of testing methods to detect stray voltage
2. Communications with municipalities regarding facility removal and abandonment
3. Operations and maintenance procedures for de-energizing facilities that have been abandoned or removed
4. Adequacy of remediation plans and implementation
5. Adequacy of record keeping procedures
6. Causes and remedies for stray voltage
7. Assessment of whether hazardous events has increased since March 1, 1998 (and if so, why)
8. Assessment of whether stray voltage hazards are due to geographic or climatic conditions
9. Assessment of whether state and municipal clearing and de-icing practices have been conducive to equipment deterioration

10. Further action to be taken to improve distribution system integrity and to ensure public safety from hazards of stray voltage

Our findings and conclusions for each of these tasks are presented in subsequent sections of this report.

Approach

NCI's findings and conclusions are based on an objective and independent assessment of stray voltage hazards. Our investigation relies on unbiased data and sources, including a critical review and assessment of utility reports and responses to information requests.[3]

Initially, NCI reviewed and analyzed information contained in reports and responses to DTE inquiries in 2004. In May 2005, NCI met with each of the utilities individually to provide them an opportunity to describe how they plan to address stray voltage prospectively. NCI then issued information requests followed by requests to confirm the accuracy of data NCI relied upon to develop its findings and conclusions (Appendix B). NCI relied on these sources to make a determination as to whether proposed actions and remediation programs by these utilities are consistently applied and effective in their ability to effectively reduce the incident rate of hazardous stray voltage events.

Other sources NCI relied on in its assessment include:

1. Industry standards and practices as set forth in IEEE, ANSI and other industry documents, journals and literature.

2. Sample practices employed by utilities in other states with extensive underground distribution systems.

[3] Throughout our report we emphasize that many of our recommendations apply to utilities not subject to DTE jurisdiction, including municipal facilities and privately-owned electric equipment. NCI did not request data from these organizations and other third parties.

3. Documented practices and application guidelines, standards, and procedures prepared by the each of the four electric utilities and equipment suppliers.

4. Previous and ongoing commission investigations in other states, such as New York.

5. Industry benchmarks established for underground distribution maintenance, testing and operations.

6. Experience gained from prior management of electric utility distribution engineering organizations and from consulting engagements where our consultants have addressed similar issues.

Documents Reviewed and Information Requested

NCI obtained several documents following its initial meeting with DTE staff, including utility reports and proposed inspection, monitoring and remediation plans. Documents NCI obtained and reviewed are listed below. Appendix A lists sources, documents, and reports NCI relied upon to support its findings.

1. Electric utility reports submitted in response to the DTE's March 2004 stray voltage directive

2. Utility mitigation plans and proposed responses issued during joint meetings with utility representatives

3. DTE correspondence with the Massachusetts Bay Transit Authority

4. DTE correspondence with the Massachusetts Municipal Association

5. DTE correspondence with electric utilities with reported stray voltage events in 2005

6. DTE June 2004 Technical Session transcripts

7. Utility responses to DTE 2004 information requests
8. Utility design standards
9. Utility maintenance practices and procedures
10. Stray voltage proceedings in New York State
11. Manufacturers' literature on voltage detection devices
12. Research reports on stray voltage phenomena

Definitions and Stray Voltage Thresholds

There is some confusion – even among those knowledgeable in electric utility operations – regarding how stray voltage should be defined. Often, stray voltage is used to describe elevated voltages, measured between neutral conductors and ground (i.e., neutral-to-earth voltage).[4] The resulting neutral-to-earth voltage typically is below 10 volts and not harmful to humans; however, animals and household pets can *detect* voltages as low as 0.5 volts. Inadequate grounding and current flows between the neutral and ground causes voltages to rise, either on the customer or utility side of the customer's electric meter. NCI's assessment generally

[4] National Grid has adopted definitions for elevated voltage levels based on a draft IEEE paper authored by a Company employee. National Grid uses the following to describe elevated voltage: (1) *Hazardous Voltage*: Any A.C. [alternate current] voltage difference between two possible human contact points that equals or exceeds 50 volts; (2) *Neutral-to-Earth Voltage*: An A.C. voltage difference between an electric delivery system neutral, and a remote point that is grounded to earth, caused by neutral-to-earth currents that normally occur in grounded neutral systems; (3) *Perceived Touch Voltage*: The level of non-hazardous voltages that could be felt by a human or animal, under normally expected conditions, may be as low as 0.5 volts and as high as 8 volts; and (4) *Elevated Equipment Voltage*: A voltage difference between utility equipment and the earth, or to nearby grounded facilities, that exceeds perceptible voltage levels for humans, assumed to be 8 volts.

excludes neutral-to-earth stray voltages, as they are not harmful to domestic pets and humans.

While there is no strict definition (at this point) as to what constitutes harmful voltage levels, elevated voltages below 8 to 10 volts generally are not detected by humans; however, elevated voltages below 10 volts may cause discomfort to some animals, particularly for domestic pets, but may not always be harmful.

Language in the National Electric Code (NEC) and the Occupational, Safety, Health Administration (OSHA) each suggest voltages harmful to *humans* generally exceed 50 volts. However, recent experience suggests far lower voltage levels may be harmful to animals. Animals do not (usually) wear protective footwear, which often has excellent insulation properties. Further, animals tend to create a more receptive electrical path than humans, as the distance between their front and rear legs often spans energized sources and ground.

The voltage threshold that should be considered hazardous is influenced by the conditions under which electric current flows in human or animal tissue. If the path between the energized source and ground is highly insulated - even when voltages are high - the resulting current (generally measured in amps) may be quite low with minimal side effects. In contrast, a highly conductive path via a low voltage source could be harmful if resistance is low. Since the path that current flows includes the human (or animal) body and ground (i.e., earth and other materials), the total resistance and resulting current magnitude can vary depending on conditions that exist at the time. For example, if the path to ground is highly saturated with moisture with salt contamination, the total resistance to ground typically will be lower than dry, non-contaminated conditions.[5]

Because of this variability, NCI believes it is in the utilities' (and the general public's) best interest to adopt a reasonably conservative threshold for stray voltage inspection and testing. Evidence and industry data suggest *potentially* hazardous

[5] The variability of ground resistance due to applied contaminants such as road salt suggests utilities should consider seasonal factors when setting equipment inspection schedules.

voltages manifest at or above 20 volts.[6] Between 8 to 20 volts, stray voltages can be detected and considered an irritant by humans.

It is important to note that the impact or level of harm associated with stray voltage is also a function of current flow, typically measured in amps. Notably, the current flow at these lower voltages can vary dramatically due to differences in body resistance and other materials that may be part of the electrical path to ground. Accordingly, there is no *precise* level at which voltage can be deemed to change from non-hazardous to hazardous. An IEEE working group is addressing stray voltage and eventually will develop stray voltage guidelines; however, the IEEE review and approval process often spans many years and the guidelines may not be issued for several years.

Given the variability described above and the absence of an IEEE standard, NCI believes the DTE should adopt 20 volts as an interim threshold for detection and measurement. The threshold can be modified upon the approval of an appropriate standard.[7] NCI encourages utilities to use a lower standard if the detection devices employed are guaranteed to a lower voltage.

Causes of Stray Voltage

Stray voltage as applied in NCI's assessment usually is caused by direct contact of secondary cable with conductive materials or equipment, or by improper

[6] A New York utility has reported to its state commission that the highest level a human can withstand without injury is 19 volts. Twenty volts is considered potentially hazardous, where hazardous is defined as the inability of a human to be able to always detach from the energized source.

[7] Some of the voltage detection probes used by utilities in 2004 are guaranteed by suppliers at 24 volts. The City of Boston's Joint Task Force recently adopted a 24-volt level for stray voltage detection. NCI encourages utilities to notify equipment suppliers of the proposed 20-volt standard, if adopted by the DTE. NCI is mindful that a 20-volt standard, which is stricter than the 24-volt guarantee or rating of *some* equipment suppliers, potentially raises regulatory or enforcement issues, given manufacturers' warrantee limitations. NCI, however, bases its choice of a 20-volt standard on present and longer-range safety concerns rather than on the limitations of detection equipment offered by some suppliers.

installation such as reversed leads (connections) on street light cables. When direct contact occurs, voltages on non-utility equipment may approach those of the energized conductor, which can range from 120 to 240 volts for cables serving residential and small commercial systems, and 277 to 480 voltages for cables serving large commercial or industrial customers. Direct contact typically occurs when cable insulation has been degraded, cut or vandalized, and then comes into contact with conductive material or devices.

The following table summarizes equipment subject to stray voltage and the underlying causes. Notably, the types of facilities utilities inspected in response to the DTE's March 2004 directive did not necessarily include each of these equipment or material categories, in large part because there is not a consensus among utilities that stray voltage can occur on each of these devices or equipment. A compelling view suggests that stray voltage cannot occur on properly bonded (ground) equipment. NCI agrees with this proposition, but recognizes that some stray voltage events have occurred due to improperly bonded systems or higher than normal ground resistance.

Equipment Subject to Stray Voltage	Likely Sources and Causes of Stray Voltage
Secondary cables (120 volts to 600 volts)	Severed cables can elevate voltages on utility or non-utility equipment up to secondary cable voltages. Includes cut-offs for abandoned facilities
Padmount transformers or equipment enclosures	Severed low voltage cables or energized neutral wires can elevate voltages on transformer or equipment enclosures
Street light poles	Severed low voltage cables, reversed connections or unbonded equipment can elevate voltages on metal conduit (risers) and street light poles
Metal risers	Severed low voltage cables can elevate voltages on metal conduit (risers) located on metal or wooden poles
Secondary pedestals and service boxes	Severed low voltage cables, energized neutrals or disloged enclosures can elevate voltages on transformer or equipment enclosures
Guy Wires	Loose or broken overhead secondary or service wires or cables that come into contact withy guy wires can cause elevated voltage
Manhole covers	Direct contact by energized conductors is unlikely. Elevated voltages on manhole covers may be caused by contaminated soils or salt-induced
Control equipment enclosures	Unbonded enclosures or secondary supply cable that comes into contact with the enclosure

Open utility boxes or unlocked enclosures also pose a potential safety hazard to the public. A particular hazard exists on street lights where termination access box covers have been removed or opened, typically via vandalism, including those located on municipally-owned streetlight poles in urban centers.

The incident rate for stray voltage appears to be higher during winter months, particularly in areas where soil or equipment contamination caused by high moisture levels and salt content create highly conductive paths to ground. NCI has been unable to obtain data that can be used to confirm this observation, in large part due to the absence of documented stray voltage events (prior to 2004) and/or low voltage cable or equipment failures. Anecdotal evidence, including several recent stray voltage events during the 2003/04 and 2004/05 winter months, appears to support this observation.

Stray Voltage Detection and Measurement Devices

Utilities test for stray voltage using probes and equipment designed to detect low voltage. The equipment utilities used for testing employed two types of detection methods. Most utilities conducted an initial test using probes guaranteed or rated by suppliers to detect voltages above a minimum threshold. Several of these devices are rated or are capable of detecting voltages at or below the 20-volt threshold. These probes do not produce a reading, only an indication (via illumination or an audible signal) when elevated voltages are present. These probes are quite reliable, and if errors occur, they tend to be false positive readings, a desirable attribute when testing for stray voltage.

The second method is to employ voltmeters that measure actual voltages – these devices also are very accurate if set up properly. Inspectors typically use voltmeters to identify voltage levels if stray voltages are first detected via probes, including elimination of false positive readings. The use of voltmeters is more time-intensive as the device must be connected to a solid ground to produce accurate readings. Care must be exercised as solid grounds may not be readily accessible in the area where measurements are made.

Listed as follows are devices utilities have used or propose to employ to detect and measure stray voltage. Each of these devices uses visual and/or audible indicators when stray voltage is present, but do not provide voltage measurements. Notably, the HD Electric Company detector, which can detect voltages as low as 6 volts

without sensitivity adjustments, has been selected by several New York and Massachusetts utilities as a preferred testing device.[8]

- *Extech Model DVA30 Proximity Detector* (National Grid in 2004) – Non-contact detector rated between 5 and 250 volts A.C. (may require sensitivity adjustments to trigger the sensor)

- *HD Electric Company Stray Voltage Detector model LV-F-5* (NSTAR and National Grid for future inspections) – Probe detects (via LED indicator) voltages between 6 and 600 volts on contact.

- *Fluke Low Voltage Alert Voltage Detector – Model 1LAC-A* (NSTAR and WMECO) – Proximity detector rated at 24 volts.

- *Triplett Type 9600 "Sniff It" AC Voltage Detector* (WMECO) – Non-contact detector that provides both visual illumination and audible signals.[9]

- *Salisbury 4244 A.C. Voltage Detector (Unitil)* – Detector provides both visual illumination and audible signals. Product literature does not list voltage ratings, but Unitil reports bench tests detected voltages as low as 6 volts.

NCI agrees with and supports the methods and equipment utilities have employed or propose to use to detect and measure stray voltage. Most of these devices should be suitable to detect *potentially* hazardous voltages, which for purposes of detection and measurement are defined to be at or above 20 volts.

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[8] The availability of devices rated to detect very low voltage may be limited over the short term as utilities in other states, notably New York, have purchased many of these devices.

[9] The 9600 model is rated to detect voltages between 30 and 600 volts A.C. WMECO initially preferred this device as it produces both visual and audible signals. However, WMECO reports the Triplett device may not be suitable in wet conditions and selected the Fluke tester (rated at 24 volts but able to detect voltages as low as 16 volts) for its inspection program. A recent updated version of the Triplett "*Sniff It*" device (Model 9601) has an adjustable control feature that enables detection of A.C. voltages as low as 5 volts.

NCI also is aware of new measurement technologies that suppliers cite as offering more efficient and extensive coverage for stray voltage detection. Sarnoff Corporation recently developed and is now promoting a detection device that can remotely detect stray voltage from vehicles. While such systems offer promise, they are unproven and have not been subject to rigorous testing by independent users, including electric utilities. Potential problems that may lead to inaccurate readings include maneuvering slow-moving vehicles in heavy traffic, detection of normal background voltages (undesirable false positive readings), barriers such as trucks parked along curbsides and inadvertent bypassing of potential sources; each of these issues eventually may be fully assessed or resolved, but NCI is not aware of definitive studies or endorsements by objective third parties to support widespread use at this time. NCI recommends that utilities monitor the performance of these devices, and other technologies developed by industry research organizations such as the Electric Power Research Institute (EPRI) and other private companies or institutions.

Stray Voltage Incident Rate

In response to DTE directives, the four utilities in 2004 inspected manholes, pad-mounted devices, streetlight poles and other equipment conducive to stray voltage. Results of these programs are summarized below.[10]

[10] NSTAR and National Grid have extended their 2004 formal inspection program to include additional equipment or to re-inspect some equipment in 2005. National Grid's program started in August 2005 and results are not yet available. NSTAR has continued to perform stray voltage inspections in 2005. As of September 10, 2005 a total of 42 events have been detected on equipment that NSTAR owns or for which it is responsible. The Company notes that of the 33 events detected in 2004, 13 were on company-owned equipment. NSTAR has revised its totals to include only those events on equipment it owns or for which it is responsible, including events that were detected during inspections, in addition to those that were reported to the Company (NSTAR employs the nomenclature, "area energized calls" to describe call-in reports of stray voltage). Under this revised approach, a total of 42 events have been detected between January 2004 and September 10, 2005, of which 14 were detected as part of the voltage testing program and 28 from area energized calls. As noted, Unitil indicated stray voltage testing is now included in its scheduled inspections and does not propose any changes to it s current equipment inspection procedures. Additional details on prospective testing programs are described later in our report.

Company	Number and Type of Facilities Inspected	Number of Facilites with Stray Voltage Detected
NSTAR	42,869 manhole locations	33
NGRID	18,361 pole locations	127
WMECO	3,243 metal street lights	5
Unitil	192 manhole locations	None
Totals	**64,665**	**165**

The inspections utilities performed in 2004 indicate the incident rate for stray voltage – based on equipment tested – is relatively low. For example, the incident rate for NSTAR and WMECO is at or less than 0.1 percent[11]; National Grid's rate was about 0.7 percent and Unitil did not detect any stray voltages.[12] Of the total number of events detected, about half were at or above levels that could be hazardous to animals or the general public.

The low incident rate suggests the level of rigor and thoroughness applied by inspection personnel could wane if incident rates were to decline below current levels. Hence, company management must continually stress the importance of the inspections to avoid complacency that understandably could set in among testing personnel, particularly if part-time or contract personnel perform the inspections under minimal direct supervision.

NCI observed some inconsistencies in the types of equipment that utilities chose to inspect in 2004. For example, National Grid and WMECO inspected and tested 100 percent of metallic street light poles, while NSTAR inspected and tested most, if not all manholes and all other equipment susceptible to stray voltage within a 10-foot radius of the manholes.[13] Unitil inspected all manholes located in Fitchburg and

[11] In 2004, WMECO found one energized metal streetlight pole as a result of a customer call prior to testing for a total of five energized metal streetlight poles detected in 2004. In 2005, WMECO found one energized metal handhole cover in a direct buried area as a result of a customer call.

[12] National Grid noted inspections with readings 8 volts and above are included in their totals.

[13] For example, utility equipment enclosures, street lights, parking meters stands and manhole covers.

proposes to test padmounted equipment and other enclosures for stray voltage on a rolling 5-year basis. None of the utilities tested all of the equipment potentially susceptible to stray voltage presented in the *Causes of Stray Voltage* section of this report. In addition, utilities separately report stray voltage events detected via inspection versus customer call-ins or those reported by third parties. NCI recommends that for tracking and reporting purposes, stray voltage incident rates include inspection data, customer calls-ins and third party notification.

Prospectively, some utilities propose to expand the equipment they will inspect and formalize these programs as part of ongoing preventive maintenance. These are described in greater detail in the *Inspection and Remediation Plans* section of this report.

Historical Records and Tracking Systems

Prior to 2004, there was a virtual absence of utility records that tracked, in a systematic manner, stray voltage events. This is due, in part, to the absence of such records in utility outage management system data bases – utilities record events into their outage data base systems usually when there is an interruption of service. Further, utility underground cable failures and abnormal events are recorded mostly for primary systems (i.e., equipment operating at 4kV and above).

Utilities collectively do not believe the number of stray voltage events has increased since 1998, citing the absence of data that would support such a conclusion; some emphasize recent public attention and media reports that create a perception of such an increase.[14] Most cite the minimal number of hazardous stray voltage events as evidence that the incident rate has not increased since 1998. Utilities also maintain that the relatively few stray voltage events detected obviated the need to create separate records or reports to track these events. Records of stray voltage events may reside in ad hoc reports or documents, but not necessarily in a *single* central file

[14] WMECO provided data that lists 8 recorded stray voltage events since 1998, but cautioned that the list contains only those events captured from existing data collection systems, and that these databases cannot be queried to produce a complete list; for example, the outage management trouble call data system cannot be relied upon to produce a complete list of such events.

or data collection system. Some events also may have been entered onto events logs for on-call systems, but these systems may not capture all stray voltage events.

Utility asset records are similarly sparse. All utilities reported that they generally do not maintain detailed records of low voltage cable and similar equipment by location or type.[15] Hence, the use of asset records and equipment attributes to identify or predict the likely type and/or location of cable and equipment most susceptible to stray voltage is not a near-term option.

Prospectively, improved record keeping of low voltage assets ultimately may be used to support predictive methods. However, NCI urges caution on use of asset records to predict stray voltage. First, updating existing records is both costly and time consuming, and may not result in accurate predictions; for example, methods using asset data bases cannot be relied upon to predict third-party damage such as road-clearing activities or vandalism. Similarly, sampling techniques likely will produce questionable results until asset records are updated and tracking systems produce data that provide a reasonable expectation that a correlation likely exists between specific equipment types (and by vintage and location) and the occurrence of stray voltage events.

Inspection Program Costs

NCI's assessment addresses the adequacy of utility efforts to address stray voltage, including trade-offs associated with proposed mitigation programs or methods. A key trade-off invariably involves the cost of implementing programs designed to eliminate, to the extent possible, stray voltage events, particularly those involving voltages sufficiently high to be harmful to humans or domestic animals.

[15] Utility fixed asset systems typically combine or group similar equipment types into "mass" accounts, which record total quantities and original cost, by year, but does not provide location-specific data. Similarly, utility mapping systems typically include very detailed descriptions of equipment type and location for facilities operating at primary voltages (equal to or greater than 2,400 volts); detailed mapping data for secondary cables and equipment may not appear on the maps.

Although NCI does not address the impact of stray voltage program implementation on electric utility cost of service or rates, we believe it is instructive to identify these costs as a percentage of each utility's distribution expense and maintenance budgets. Listed below are the costs the four utilities incurred to respond to the DTE's March 2004 directive to inspect facilities for stray voltage. The cost of performing these inspections appears to be near or below one percent of each utility's total distribution expense budget, both on an individual and composite basis.

Company	Inspection Cost	Total Distribution Expense Budget	Percent of Total Dist. Expense Budget	Distribution Maintenance Budget	Percent of Maintenance Budget
NSTAR	$ 642,467	$ 105,322,537	0.61%	$ 35,069,067	2.00%
NGRID	$ 263,000	$ 94,758,000	0.28%	$ 38,278,000	0.69%
WMECO	$ 42,500	$ 19,923,334	0.21%	$ 13,997,899	0.30%
Unitil	Nil		N/A		N/A
Totals	**$ 947,967**	**$ 220,003,871**	**0.43%**	**$ 87,344,966**	**1.09%**

Notes:

1) Above estimates exclude cost of remediation
2) NSTAR - Inspection costs based on Company estimates of 2004 expenditures to total budget
3) NGRID - Based on contractor cost to inspect 75% of streetlights; excludes cost of Company personnel to inspect remaining 25%
4) WMECO - NU's budget is prepared at the Activity and Resource level; 2004 FERC Form 1 data used to estimated budgets
5) Unitil - Company reported minimal cost for 2004 inspection; considered part of current inspection program

The above totals exclude remediation costs, which NCI believes should be a component of each Company's distribution budget, independent of stray voltage inspection and tracking programs.

Some utilities projected the cost of implementing stray voltage inspection and testing programs; for example, National Grid's 2005 stray voltage inspection cost is estimated at $1 million; and $500,000 to $600,000 annually over the next four years.[16] WMECO did not separately project the cost of future inspections as they view stray voltage testing to be a component of their direct buried facility inspection program. NSTAR reports that stray voltage testing inspection and maintenance programs will cost about $1.5 million annually.

NCI views the amounts cited above to be reasonable in light of the potential hazards associated with stray voltage. Further, the cost of inspections and testing is far less

[16] National Grid's program costs include those incurred for utilities outside Massachusetts.

than the cost of upgrading or replacing low voltage equipment on a widespread basis, an approach NCI does not recommend. However, companies that do not plan to itemize these costs in future years' budgets should consider methods that will enable the company to track the cost of inspection and remediation. Reported costs and limited projected data suggest inspection programs proposed by utilities and NCI historically comprise less than one to two percent of each company's total distribution expense budget.

Inspection and Remediation Plans

In response to the DTE's March 2004 directives and recent stray voltage events, Massachusetts utilities developed or propose to implement inspection and testing programs on an ongoing basis. Plans summarized below are in addition to inspections and remediation activities performed in 2004.

1. National Grid and NSTAR each propose to conduct follow-up inspection and re-testing of some equipment inspected in 2004 and other equipment not included in their 2004 testing programs. National Grid plans to retest 25 percent of street lights in 2005 and all street lights in the next 12 months. In 2005, NSTAR proposes to verify the cutoff status of all former streetlight or service locations not previously reported to the Company. NSTAR also is implementing a series of 15 measures as outlined in the City of Boston's Joint Task Force on Electrical Safety.

2. Most utilities are implementing formal inspection programs for underground facilities subject to hazardous stray voltage as follows:

    a. National Grid – Inspect 100 percent of all distribution poles[17] (over 1 million) and test publicly accessible equipment in next three years; 100 percent inspection of most padmounted equipment on a rolling 5-year basis, including transformers, switchgear, pedestals and other types of enclosures.

[17] National Grid notes that underground cable is attached to about twenty one thousand of these poles, about two percent of the total population.

b. NSTAR - Institute a stray voltage inspection program of all above ground equipment in its service territory on a three-year rolling basis.

c. WMECO – Include testing for stray voltage in the Company's 5-year inspection schedule for direct buried facilities.

d. Unitil – Updated bulletins to include voltage testing of manholes and nearby facilities during annual inspections or when entered into by crews; the bulletins include inspection of underground distribution facilities on a five-year rolling basis, but these do not specifically cite testing for stray voltage on padmounted equipment or other facilities accessible by the public.

The following table summarizes programs proposed in 2005 and beyond.

Company	Proposed Inspection Program
NSTAR	Inspect all electrical facilities within its service territory on a 3-year rolling basis
National Grid	Re-inspect 25% of street lights previously inspected in 2004 Inspect all other street lights in 2005 Inspect 100% of all distribution poles within 3 years Inspect 100% of publicly-accessible equipment within 3 years Inspect 100% of all padmount equipment on a 5-year rolling basis Update secondary equipment records
Unitil	5-Year inspection of pad-mounted equipment Annual manhole inspections (Each of the above are existing programs)
Northeast Utilities	5-Year inspection of direct buried facilities (existing program)

3. Improved recording and verification of cut-offs at manholes, demolition sites and street lights. NSTAR implemented such a program in 2005.

4. Enhanced public and community outreach programs, including public service announcements regarding safe work practices. NSTAR is participating in such programs as outlined in the Joint Task Force in the City of Boston.

5. Work force training with regard to stray voltage detection and inspections. NSTAR and National Grid have updated operating procedures for responding to or procedures to be followed when detecting stray or elevated voltages.

6. New or enhanced bulletins or standards for equipment testing, testing or work methods. For example, National Grid has issued or updated safety bulletins outlining updated standards for street lights, risers and manhole/handhole standards, with appropriate emphasis on grounding methods and procedures. It includes updated electric operating procedures for addressing Shock and/or Earth-to-Neutral Voltage Complaints. New equipment standards include use of secure foundation covers and cones where street lights have been dislodged.

7. Improved coordination among customers, contractors and company personnel involving the installation and inspection of electric facilities.

8. National Grid proposes to improve accountability though the creation of a new group responsible for "managing the inspection, testing, reporting, documentation and remediation of all elevated voltage related issues." The group will report to the Vice President of Distribution Planning and Engineering.

9. NSTAR participated in the City of Boston's Joint Task Force (City of Boston service area only) – NCI notes that recommendations and programs outlined in the Task Force report, particularly with regard to public outreach, the role of municipalities and communication protocols could serve as a model for other communities in Massachusetts.

NCI addresses the adequacy of these programs in subsequent sections, including recommendations for monitoring and tracking program effectiveness.

Practices Employed in Other States

At this time, New York appears to be the only state that has opened a formal investigation of hazardous stray voltage. In New York, jurisdictional utilities now are required to conduct periodic inspections and measurements for stray voltage.[18]

NCI surveyed other utilities to determine whether formal inspection and testing programs are employed or proposed in other states to assess their awareness of and approaches to resolving stray voltage, defined as unintentional energized equipment above 8 volts.

Numerous electric utilities were contacted and five agreed to provide responses with the agreement that their identities would not be disclosed. Some are multi-state[19], and each serves high population urban and suburban city centers. Geographically they represent the Mid Atlantic, Southern, Mid West, and Western regions of the United States. Each utility serves a mix of underground and overhead electric distribution. In addition, each has a mixture of utility and private owned electrical equipment including streetlights.

NCI posed three questions pertaining to awareness of hazardous stray voltage issues, and if applicable, details regarding the utilities' programs and practices:

1. Does your utility have a stray voltage testing and remediation program? If so, was the need for the program driven by internal or external concerns?

2. If there is a formal stray voltage program, what equipment is used to test for stray voltage?

[18] The NYPSC's order requires all jurisdictional utilities to conduct stray voltage tests annually and to inspect *all* equipment at least once every five years.
[19] Over ten states are served by these utilities.

3. If there is a formal stray voltage program, what are the inspection cycles and type of equipment tested (e.g. Manholes, Service boxes, Transformer Enclosures, Street lights or other)?

Responses are summarized below.

Utility 1 – Mid Atlantic Region

Utility 1 indicated it is familiar with the New York PSC ruling on stray voltage, and used that as one of the main drivers to investigate the scope and breadth of the stray voltage issues in their service areas in 2005. While there are no state regulatory requirements for testing of stray voltage, this utility is initiating procedures to adequately respond to future questions and concerns.

Utility 2 – Southern Region

Utility 2 indicated it is familiar with the New York PSC ruling on stray voltage but has no plans to formally inspect all electric facilities. This utility has a procedure to investigate and resolve stray voltage, defined as greater than 8 volts. Most stray voltage events have not been located on street lights or service boxes, but rather near or at swimming pools; in particular in-ground pools with poured in place concrete without rebar (bonded rebar reduces the likelihood of stray voltage).

Utility 3 – Mid West Region

Utility 3 is aware of the New York PSC ruling on stray voltage but has no plans to formally test all electric facilities. While there is not a tailored program for inspections, internally there is sensitivity that if a stray voltage is reported it must be investigated and resolved promptly.

Utility 4 – Western Region

Utility 4 is a multi-state jurisdictional utility with a high concentration of dairy farms. State regulatory agencies track farm-related stray voltage issues. Because stray voltage complaints are more common for neutral-to-earth events, internal remediation programs focus on stray voltages less than 5 volts. While there are no

plans to test for stray voltage in their underground distribution system, there is an increased awareness of the issues and regulations in New York.

Utility 5 – Mid West Region

This utility is aware of the New York State investigation on stray voltage, and subsequently tested a sample of area of their underground distribution system. Based on sample results (one or two street light enclosures were energized), this utility decided that a formal targeted program outside of their existing underground inspection program was not warranted. However, they have increased awareness training for the inspectors and other employees on stray voltage issues. Notably, the locations where they experienced elevated voltages were in street lights that appeared to be inadvertently cut and then incorrectly repaired by outside contractors who reversed the street light supply lines.

In summary, all utilities surveyed are familiar with the program and testing requirements of the New York PSC Order, though none have instituted formal programs for measuring and testing for stray voltages greater than 8 volts. All utilities stated they are cognizant of stray voltage and other contact hazards and therefore, have formal policies and procedures in place to promptly investigate and resolve these conditions.

Findings

Summarized below are NCI's findings based on information obtained and studies performed as of September 23, 2005.

1. Utility responses to the DTE's March 2004 directive resulted in the detection of numerous instances (over 100) of stray voltage, with voltages ranging from 8 volts to full secondary line voltage. Many readings were at or below levels that would be considered harmful to humans or domestic animals.

2. There was some inconsistency in the types of equipment inspected during 2004; some utilities focused on manhole locations whereas others inspected streetlight poles.

3. The causes and sources of stray voltage vary. Detection of stray voltage for the Massachusetts utilities appeared mostly on street light poles, metal risers and equipment enclosures. Manhole covers do not appear to be impacted by stray voltage to the same extent as other utility equipment.

4. The primary reason why stray voltages remain undetected is the absence of protective devices that can quickly detect and isolate elevated voltages on electric utility secondary equipment; that is, equipment operating at 600 volts and less. Currently, there do not appear to be any protective devices available in the commercial market that can perform this function, in large part because the electrical characteristics of equipment susceptible to stray voltage are very similar to customer electrical loads.

5. The presence and causes of stray voltage is not limited to facilities owned and operated by electric utilities. Utilities have reported many instances of stray voltage where the source or cause resulted from equipment owned by municipalities or other third parties.

6. The equipment utilities and their contractors have used for field testing is suitable and sufficiently accurate to identify hazardous stray voltages. Devices that may detect stray voltage more efficiently recently became available, but are unproven and should not used in lieu of direct testing methods at this time.

7. Accurate records of the type and condition of secondary cables and equipment by location is limited. Fixed asset systems, facility data bases and mapping systems historically used by utilities in Massachusetts and other states usually do not include the same level of detail used for secondary systems as used for higher voltage, primary systems.

8. Most Massachusetts utilities generally do not budget for the scheduled replacement of low voltage secondary equipment and cables.[20] The absence

[20] Exceptions include replacements performed in conjunction with load growth, targeted upgrades or secondary networks upgrades or replacements.

of accurate records of equipment type, condition and failure data by location makes such programs difficult to structure or justify. Also, the limited number of customers impacted by low voltage equipment failures usually is far lower than primary voltage events.

9. While it is difficult at best to predict the incident rate for stray voltage, the absence of widespread secondary cable and equipment replacement programs (and degradation due to environmental factors or local operating conditions) suggests that stray voltage events likely will continue over time.[21] Some utilities have developed targeted secondary equipment replacement programs, which may reduce respective stray voltage incident rates. Utilities should monitor the effectiveness of these replacement programs to determine if inspection intervals should be adjusted. For example, if targeted equipment replacement programs cause the stray voltage incident rate to decline for the type of equipment replaced, it then may be appropriate to lengthen the inspection interval.

10. There are minimal documentation or data bases that accurately recorded stray voltage events prior to 2004. Such records and tracking systems are essential to identify causes of stray voltage and to assess the effectiveness of detection and remediation programs.

11. There are insufficient records to confirm that the number of hazardous stray voltage events has increased since March 1998; however, anecdotal evidence based on the relatively high number of hazardous events reported events in 2004 and 2005 suggests the incident rate is rising in some areas. Additional investigation is necessary to confirm this observation.

12. There appears to be an increase in the number of hazardous stray events that occur in winter months when contamination and high moisture content increases the susceptibility of equipment to elevated voltages. Additional

[21] NCI's experience suggests age alone cannot accurately predict equipment condition or likelihood of failure. Rather, a condition assessment based on the operating environment, equipment loading, fault duty, prior failures and known susceptibility factors is necessary to identify equipment likely to experience higher failure rates or degraded performance.

investigation of reported events and recorded data is needed to establish the rate of increase caused by environmental and seasonal factors.

13. National Grid and NSTAR have stepped up efforts to implement stray voltage inspection and remediation programs. Unitil and WMECO consider inspections and stray voltage detection to be part of their normal inspection and maintenance procedures, and point to the relatively few instances of recorded events or low detection rate in 2004 as justification for continuation of current programs.[22]

14. All utilities have operations and maintenance procedures for de-energizing facilities that have been abandoned or removed. There is some concern that incomplete records or non-reported abandoned facilities still pose some risk in urban areas, particularly Boston. NSTAR has agreed as part of the City of Boston's Joint Task Force to verify the cutoff status of all former streetlight or service locations not previously reported to the company.

15. The cost of performing the inspections in 2004 did not appear to be unduly burdensome from a cost standpoint. The cost of programs utilities propose in 2005 and beyond also appears to be reasonable compared to the total cost of maintenance programs.

16. Utilities in a few states have encountered hazardous stray voltage conditions (or are responding to the potential for such hazards), and have developed or mandated inspection and remediation programs. However, the majority of utilities in other states have not implemented formal inspection and testing programs to detect stray voltage.

NCI recognizes that it is not possible to entirely eliminate stray voltage events, nor is it practicable or cost-effective to replace low voltage equipment on a widespread basis as a means to entirely eliminate the possibility of stray voltage hazards. Further, at this time manufacturers do not offer protective devices that can detect and isolate stray voltage without compromising the continuity of electric service to

[22] Unitil and WMECO in some instances have modified inspection procedures or forms to include testing for stray voltage.

customers. Effective reduction of stray voltage is best achieved via appropriate equipment selection and proper installation. In addition, a plan to reduce stray voltage events should include targeted inspection and testing programs, combined with public awareness initiatives and reporting of known or potential hazards. Active participation by other entities, including contractors and public works departments also is essential, as each are responsible for maintaining their equipment in good working order.

The detection of hazardous stray voltage is most successful when all entities that have a role in providing electric service recognize the inherent potential of any electrical device – utility or non-utility owned - to produce stray voltage. Historically, the number of hazardous stray voltage events has been low and until recently (in New York), few human fatalities have occurred as a result of stray voltage. However, recent dog fatalities and an apparent increase in the number of reported stray voltage events in Massachusetts and other states suggest that an active monitoring and detection program is an appropriate response.

Notably, several Massachusetts utilities recently instituted formal inspection and testing programs that should help to detect stray voltage hazards and reduce the incident rate. Because the number of stray voltage events is relatively low, continued management emphasis and focus on these programs is paramount. Such emphasis and continuity can be assured through formal reporting of stray voltage programs and events by jurisdictional utilities to the DTE.

DTE Issues Assessment

Provided as follows are NCI's summary responses to issues and questions raised by the DTE with respect to utility practices and procedures. Additional details and rationale are provided in other sections of this report.

Adequacy of testing methods to detect stray voltage

> ***NCI Assessment:*** *The testing probes and measurement devices generally available are adequate to detect stray voltage that meet the hazardous threshold defined herein.*

Utilities should monitor new technologies to determine if they can provide more efficient, accurate and cost-effective detection of stray voltage than conventional methods.

Communications with municipalities regarding facility removal and abandonment

NCI Assessment: *Historically, communications with municipalities regarding removal and abandonment has been sporadic among some utilities; current and proposed practices appear to have improved, and should reduce the incident rate for stray voltage. The DTE should consider forwarding our recommendations to municipalities or municipal organizations to further promote and improve stray voltage inspection, removal and abandonment procedures, and communications procedures described in our report, including the use of bulletins, mailers and contractor guidelines.*

Operations and maintenance procedures for de-energizing facilities that have been abandoned or removed

NCI Assessment: *Historically, some utilities capped abandoned cables at the point of disconnection. These practices no longer are being employed by any of the jurisdictional utilities, and efforts are underway to check existing facilities that have been abandoned or removed. NCI agrees with the revised policies and inspection of existing facilities. However, the disconnection and capping of energized low voltage cables in handholes creates a potential safety hazard if such terminations are not secure and could come into contact with the metal sides or covers.*[23]

Adequacy of remediation plans and implementation

NCI Assessment: *Prior to 2004, remediation plans were implemented sporadically; typically when a stray voltage event was reported and identified. Since 2004, all utilities have initiated inspection programs, and some propose more aggressive testing in 2005 and beyond. However, there is some degree of inconsistency among the utilities relative to the type of equipment that will be inspected, inspection frequency and how such information will be tracked and monitored. NCI does not recommend all utilities*

[23] Some utilities report that many handholes in their service territory are privately-owned or owned and maintained by local municipalities.

necessarily adopt the same inspection methods or intervals. However, inspection intervals should not exceed five years. Further, DTE oversight may be appropriate, at least in the next 3 to 5 years, to ensure remediation programs are consistently employed, monitored and assessed with regard to adequacy.

Adequacy of record keeping procedures

NCI Assessment: *Historically, most utilities have not systematically and consistently maintained records of stray voltage events, in part because of the low incident rate and the absence of customer outages when such events occur. Prospectively, utilities should implement methods and procedures to track stray voltage events and other hazardous conditions. Some have begun to modify existing systems or introduce new tracking methods. Since the amount of information collected thus far is limited, NCI recommends utilities formally submit reports that will enable the DTE to assess progress and the effectiveness of utility record-keeping procedures. Utilities also should consider methods to expand or enhance asset databases of low voltage equipment to enable then to prioritize inspection schedules, and replace deteriorated or damaged equipment on a targeted basis.*

Causes and remedies for stray voltage

NCI Assessment: *The leading causes of hazardous stray voltage are damaged cables (inadvertent and intentional vandalism) that contact conductive materials, incorrect installation (utility and non-utility), and improper grounding and deterioration of equipment and cable insulation. The most effective remedy to detect stray voltage is to implement comprehensive inspection and testing of equipment susceptible to stray voltage, enhance public awareness via use of mailers and bulletins, and streamline notification processes for abandoned facilities, damaged utility equipment or street light removals. This recommendation should be adopted by municipal, cooperative and privately owned electric facilities to be fully effective.*

Assessment of whether hazardous events have increased since March 1, 1998

NCI Assessment: *There is no direct evidence that the total number of stray voltage events has increased since March 1, 1998. However, there appears to be anecdotal evidence and records based on recent events in Massachusetts and other states to suggest*

the number of hazardous events has increased. NCI recognizes heightened public concern may have caused an increase in the number of reported events.

Assessment of whether stray voltage hazards are due to geographic or climatic conditions

NCI Assessment: *There is a strong likelihood that some stray voltage hazards are due to seasonal or locational factors, including areas where moisture, salt or contaminants increase soil conductivity. Inspections should be scheduled during months when such hazards are greatest. NCI recognizes that some equipment may be difficult to access during winter months and therefore, utilities may elect to schedule some inspections in the early spring months following the winter thaw.*

Assessment of whether state and municipal clearing and de-icing practices have been conducive to equipment deterioration

NCI Assessment: *While there is minimal substantive evidence that municipal clearing and de-icing practices have increased the number of hazardous stray voltage events, the information NCI has collected, technical reports and our experience each indicate that equipment corrosion, erosion, displacement and direct damage occurs as a result of municipal clearing practices.*

Further action to be taken to improve distribution system integrity and to ensure public safety from hazards of stray voltage

NCI Assessment: *The most effective action that utilities can employ for facilities they own is proper equipment installation coupled with an effective preventive maintenance program. Preventive maintenance should include comprehensive inspection and testing of distribution equipment operating at low voltage that is accessible by the general public and domestic animals. Equipment experiencing stray voltage or that has sustained damage or deterioration which increases the susceptibility of the equipment to stray voltage should be repaired or replaced. These programs should be perfomed in concert with outreach and education programs that include general public, contractors and municipalities. NCI does not recommend widespread replacement of secondary distribution equipment. However, utilities should collect data from prior and future stray voltage events that might provide a basis for targeted replacement or upgrades.*

Recommendations

Based on our findings and responses to issues raised by the DTE, NCI recommends that the Massachusetts utilities under the DTE's jurisdiction:

1. Prepare or update preventive maintenance plans, where needed or appropriate, to include inspection and testing of low voltage secondary equipment and facilities susceptible to stray voltage levels that exceed the thresholds described herein. Such plans and documents should include or consider:

   - **Sources** – Identify and include likely sources of equipment susceptible to stray voltage, including exposed cable leads, exposed metal conduit and risers, metallic street light poles, padmounted devices, equipment enclosures, pedestals, and exposed grounds. At minimum, NCI recommends all utilities inspect and test the following equipment where accessible by the general public:

     - Metallic street lights and fixtures
     - Metallic risers, sweeps and conduits
     - Manhole and handhole covers
     - Secondary pedestals
     - Padmount transformers and transclosures
     - Padmount switchgear, termination cabinets and junction boxes
     - Control cabinets such as pole-mounted capacitor controls

     Voltage testing of many of the above equipment categories often can be performed concurrently with other scheduled visual inspection or preventive maintenance programs.

   - **Schedules –** Prioritize inspection schedules based on susceptibility or prior history of recorded stray voltage events by equipment type. NCI does not prescribe or recommend specific schedules or intervals that apply to all utilities. Utilities should be permitted to propose inspection schedules and methods based on prior inspection results, equipment

exposure, coordination with other inspection and preventive maintenance programs, and locational factors. At minimum, NCI recommends utilities schedule voltage testing on a rolling 5-year basis. NCI recommends utilities prioritize voltage testing based on the following criteria, ranked from highest to lowest priority:

- Areas of high exposure from prior inspections should receive highest priority
- Equipment with the highest historical incident rate or with the highest known risk factors
- Equipment that is more susceptible to stray voltage during winter months when contamination or clearing increases the incident rate
- Equipment categories listed above that have not been inspected or tested in the past 5 to 10 years, or that have never been inspected
- Areas with a high density of equipment types listed above, such as residential and commercial subdivisions.
- Rural areas where lines and equipment is located overhead and is generally inaccessible by the public may be assigned a lower priority.

» **Seasonal factors –** Schedule inspections during periods where equipment may have greater susceptibility to stray voltage; for example, during winter months due to possible damage caused by clearing activities or lower ground resistance created by salt or contamination. Utilities should be provided an opportunity to gather factual information to identify seasonal impacts on equipment stray voltage susceptibility, and structure or modify programs based on this information. Utilities that propose such an approach should describe the methods they will employ to collect the factual information and how this information will be used to identify inspection schedules based on seasonal factors. Utilities should describe proposed methods in the implementation plan described later in this section.

» **Mitigation and Remediation –** NCI recommends that utilities immediately repair, replace or disconnect equipment with voltage readings of 20 volts or greater. All equipment with readings between 8

and 20 volts should be repaired within 24 hours and equipment with readings below 8 volts should be addressed at the utilities' discretion; however, utilities should cordon off the equipment or facilities with voltages between 8 and 20 volts if inspection personnel or repair crews are not present at the site at any time prior to repairs. Mitigation and remediation may include disconnection of service to a customer's premise if the source or cause of the stray voltage is customer-related or if the stray voltage is present on or caused by municipal or other publicly-owned facilities. However, utilities should employ best efforts to contact and provide the customer or municipality a reasonable opportunity to correct the problem prior to disconnection. The above threshold and communications protocol should be incorporated into each utility's preventive maintenance manuals, bulletins or notification procedures.

2. Implement consistent monitoring and tracking systems that record and document stray voltage events. These reporting systems should include equipment impacted, system conditions, remediation, and other relevant information designed to enhance root cause analysis and targeted inspections. At minimum, the monitoring and tracking systems should include the following attributes and features:

   - Links to trouble order or customer information systems to ensure all stray voltage events are captured
   - Menu-based data entry and definitions
   - Established procedures to classify stray voltage events
   - Procedures or policies that document equipment that should be tested seasonally when the incident rate is highest
   - Event data including,
     - Location of event
     - Name of person reporting the event (if available)
     - Date and time event detected or reported
     - Feeder and substation number
     - Equipment impacted and damage report
     - Equipment owner (utility, municipality, customer)
     - Equipment condition
     - Voltage reading(s)

  - Inspection/testing/call out personnel/crews
  - Type of mitigation employed
  - Date of mitigation
  - Injuries (if any)
  - Date of report to DTE

- Tracking reports that list stray voltage events by equipment type, voltage readings, and location by area/region

Ideally, the monitoring and tracking system would include the ability to query data and produce interim reports via menu-based systems.

Utilities are encouraged to jointly discuss development and use of a common tracking and recording system.

3. Submit reports to the DTE that document and summarize information obtained in Recommendation 2. At minimum, these reports should include:

   - Annual reports that list inspection and testing data, including number of inspections conducted by equipment type
   - Number of stray voltage events detected by inspection personnel versus calls-ins or notification by third parties
   - Variance reports on current year inspection targets
   - Stray voltage events detected on equipment that is not included in stray voltage equipment inspection schedules (which will enable the DTE to determine if the company is inspecting and testing the correct equipment)
   - Number of exceptional or non-routine events that required reporting to OSHA or other government organizations due to injuries or other substantive impacts.
   - All exceptional and non-routine events described above should be submitted to the DTE within one to three days. Events involving a fatality or injury (human or domestic animal) should be reported immediately.

In addition to the above, utilities should consider reporting the following information:

- Clear and concise table and charts that track the data listed in Recommendation 2
- Proposed schedules that summarize inspections scheduled for the following year
- Cost of inspections and mitigation activities
- Results of internal studies or industry activities involving stray voltage testing and detection methods, or stray voltage phenomena
- Results of investigation of new testing devices or methods, particularly those that offer cost-effective alternatives

Utilities should consider assigning individual(s) who are responsible for issuing these reports and responding to questions regarding the company's stray voltage program.

4. Monitor and assess alternate testing methods, including new equipment that will improve inspection efficiency and cost.

5. Promote safety awareness via mail, bill stuffers and contractor bulletins to the extent these processes are not already in place.

6. Explore and promote the development of protective equipment with electric equipment suppliers that can differentiate and isolate stray voltage from normal customer electrical loads.

NCI's recommendations are based on information and programs that were in place as of the ending date of the assessment (September 2005). NCI recognizes some utilities have initiated or propose to implement some or most of the recommendations described above. However, there are gaps or differences among utilities with regard to proposed inspection and testing programs; in particular, the types of equipment included in proposed inspection programs and tracking systems.

Accordingly, NCI recommends that the DTE direct each jurisdictional utility to submit an implementation plan or report in response to each of our recommendations. The plan should clearly outline the frequency of inspections, types of equipment to be tested, testing methods, sample formats for tracking and reporting detected stray voltages[24], DTE notification procedures when a human or domestic animal has sustained an injury as a result of stray voltage, and key utility contacts. Where differences exist in these plans, DTE should consider the following factors in reviewing the appropriateness of each company's plan:

- *Historical incident rates by equipment type*. For example, some utilities reported a much higher incident rate for street lights and it may be appropriate to inspect street lights more often than other equipment.

- *Incident rate*. At least one utility reported no incidences of stray voltage since March 1998. Continuation of existing programs with minimal changes may be appropriate if the historic rate is low or if current or proposed inspection programs result in a very low incident rate over time

- *Operating environment*. Equipment that is continually subject to third-party damage or municipal clearing due to proximity (such as urban areas or main thoroughfares), should receive greater attention.

- *Location*. It may be appropriate to adjust inspection schedules for facilities that are mostly overhead or located in sparsely populated areas where most equipment is not accessible to the public.

NCI encourages the DTE to notify non-jurisdictional utilities, municipalities and other organizations that have a role in public safety of the findings and recommendation contained in this report. The Joint Task Force (City of Boston) report could serve as a model for joint programs that would involve the local utility, municipal representatives, contractors and other affected parties.

[24] Utilities are encouraged to adopt a common format for these reports.

Appendix A

Sources and Citations

1. "Report of the Joint Task Force on Electrical Safety", City of Boston, NSTAR, et. al., July 2005.

2. "Proceeding on the Motion of the Commission to Examine the Safety of Consolidated Edison Company of New York, Inc's Electric Transmission and Distribution Systems," New York Public Service Commission, Order on Proposal issued July 30, 2004, Order on Petitions for Rehearing and Waiver issued July 21, 2005.

3. Technical Transcript, "Stray Voltage and Stray Voltage Reports Provided by Electric Utilities on April 14, 2004" Massachusetts Department of Telecommunications and Energy, June 23, 2004.

4. "A Review of Hazards Associated with Exposures to Low Voltages," . M. Biksom, City College of the City University of New York, 2004.

5. Letter Report to National Regulatory Research Institute - "New Jersey Stray Voltage/Ground Current Investigation & Final Assessment", VitaTech Engineering, LLC, November 2, 2002.

6. "Standard Handbook for Electrical Engineers," *Threshold Levels for 60-hz Contact Currents*, p. 14-48. Updated August 11, 2004.

7. "NSTAR Electric Report to the Department of Telecommunications and Energy on the Underground Distribution System," April 15, 2004.

8. "Massachusetts Electric Final Report to the Department of Telecommunications and Energy on Elevated Equipment Voltage," April 14, 2004. Updated October 1, 2004.

9. Unitil, Letter Report to the Department of Telecommunications and Energy on Stray Voltage, April 16, 2004.

10. Western Massachusetts Electric, Letter Report to the Department of Telecommunications and Energy on Grounding, Electrical Shock and Hazardous Voltage Testing Results, March 12, 2004 and April 14, 2004. Updated July 13, 2004.

11. Massachusetts Bay Transportation Authority, Letter to the Department of Telecommunications and Energy on AC Cable Network Inspections," December 2, 2004.

12. Equipment and Construction Standards, Bulletins, Operating Procedures, and Work Practices for each of the four jurisdictional utilities submitted to the DTE or NCI during the Assessment (Voluminous).

13. "In the matter on the Commission's own motion, of the investigation into methods to improve the reliability of electric service in Michigan," Case No. U-12270, Michigan Public Service Commission, November 25, 2003.

14. "In The Matter of the Board's investigation into allegations of Stray Voltage Occurrences with the Service Territory of Jersey Central Power & Light Company," Docket No. EO02120923, New Jersey Board of Public Utilities, April 28, 2004, April 28, 2004.

15. "Investigation on the Commission's Own Motion Into the Practices, Policies and Procedures Concerning Stray Voltage for Electric Distribution Utilities in Wisconsin," 05-EI-115, Public Service Commission of Wisconsin, July 16, 1996.

Appendix B

Information Requests

Stray Voltage Assessment of Massachusetts Electric Utilities

NCI Data Request No. 1

Navigant Consulting Inc. requests the following information from each of the electric utilities subject to the Massachusetts Department of Telecommunications and Energy (DTE) investigation of stray voltage on electric utility systems. Where information is partially available for some, but not all years, please provide the partial information and an explanation as to why such information is not available and the steps necessary to collect the information. If the requested information is deemed confidential or proprietary, please so indicate. Responses may be submitted by mail or where applicable, electronically, to the following address. Note that electronic submissions are preferred; original or hard copy attachments or illustrations that accompany electronic responses may be submitted separately by mail.

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(802) 233-1890 (mobile)

Solely for purposes of this and subsequent information requests, "stray voltage" means any measured voltage at or above 8 volts or any instance where a third-party inquiry or complaint resulted in measured voltages at or above 4 volts. For purposes of this and subsequent information requests a "stray voltage event" shall include any abnormal event or situation that caused voltages on utility, municipal or customer-owned devices to exceed the above thresholds.

NCI is submitting this initial data request to all utilities. Accordingly, the term "utility" or "company" shall refer to the utility receiving this request. Subsequent data request will refer to the utility by name. NCI expects that subsequent information requests will be issued following the receipt of utility responses to this initial request.

Please provide responses 10 days following receipt of this request. NCI understands that some of information requested may require more than 10 days to obtain or complete. Accordingly, for those requests that will require more than 10 days, please indicate when responses will be provided.

1. Please provide a list of all stray voltage events that have been identified and recorded by utility personnel since March 1, 1998. The response should include:
    a. Date, time and location of the event, including devices or equipment where stray voltage thresholds as defined above were exceeded.
    b. Magnitude of the stray voltage measurement(s) – the measured voltage for each device at each location should be noted.
    c. The likely cause(s) of the stray voltage (utility and non-utility sources).
    d. The remediation employed by the utility to eliminate the stray voltage condition; include methods employed by third parties, where known, if the equipment or circumstances that caused the event was not under ownership or control of the utility.

2. Has your company adapted a standard or standard definition for "stray voltage" or "stray voltage events"? If yes, please provide such standard(s) or definition(s).

3. Does your company believe that the number of stray voltage events has increased, decreased or has remained constant since March 1, 1998? If the number of events has increased or decreased, please provide the most likely explanation for the change in recorded events.

4. What methods or criterion has or will your company employ to prioritize inspection and testing of equipment and devices for stray voltage?

5. What is your company's plans regarding future inspections for stray voltage? Does your company plan to test additional equipment and devices that may not have been inspected in 2004? Please state or provide documentation, standards, maintenance or inspection procedures or other descriptive documents that describe such plans.

6. Please provide separately the cost of conducting inspections and measurements for stray voltage and the cost remediation of detected events in response to the DTE's 2004 request.

7. What was the cost of conducting inspections and measurements for stray voltage as a percentage of the company's total distribution expense budget? Also, provide similar percentages relative to the company's distribution maintenance budget.

8. What is the projected cost (expense) of future inspections for stray voltage (non-farm) that your company will include in its budget for the next 5 years, beginning in 2005?

9. Please provide a list of the voltage measurement devices the company considered for the inspections and measurements conducted in 2004, the device(s) that were used for conducting the measurements, and the reasons why the device(s) used were selected versus other options.

10. Please provide the following data (actual based on plant accounting records, GIS/AM/FM or best estimates):

    a. Miles of underground secondary cable by type, size and vintage (mass account data by year is sufficient).
    b. Miles of underground service cable by type, size and vintage (mass account data by year is sufficient).
    c. Number of manholes containing secondary cable and estimate of installations by year.
    d. Number of conductive or semi-conductive street light poles owned by the company.

11. Does the company maintain reports, data or event logs of stray voltage events (non-farm), resulting either from third party complaints or from company or contract personnel? If yes, please provide copies of such reports as of March 1, 1998.

12. What are the company's procedures regarding the de-energization of secondary conductors and services that no longer serve load due to the abandonment or removal of the customer's facility or streetlight(s)?

13. Does the company have a secondary cable replacement program included in its current or prospective budgets? If yes, please indicate the methods and criterion to prioritize replacements and the amount of cable that will be replaced.

14. Has your company determined that seasonal factors contribute to an increase in stray voltage events; for example, use of road salt and de-icing methods during winter months? If yes, what data did your company rely on to make this determination?

15. Since March 1, 1998 how many streetlights, by town or city, have been sold or otherwise transferred to municipalities or other third parties?

16. Please provide a copy or description of your design standards for those devices that have experienced stray voltage; in particular for manholes, hand holes, and streetlights.

Stray Voltage Assessment of Massachusetts Electric Utilities

NCI Data Confirmation Request No. 1

Navigant Consulting Inc. requests confirmation of the following information from each of the electric utilities subject to the Massachusetts Department of Telecommunications and Energy (DTE) investigation of stray voltage on electric utility systems. Where information is deemed partially or entirely inaccurate, please provide corrected information and an explanation as to why your company believes the information is inaccurate. If the requested information is deemed confidential or proprietary, please so indicate. Responses may be submitted by mail or where applicable, electronically, to the following address. Note that electronic submissions are preferred; original or hard copy attachments or illustrations that accompany electronic responses may be submitted separately by mail.

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(802) 233-1890 (mobile)

Solely for purposes of this and subsequent information requests, "stray voltage" means any measured voltage at or above 8 volts or any instance where a third-party inquiry or complaint resulted in measured voltages at or above 8 volts. For purposes of this and subsequent information requests a "stray voltage event" shall include any abnormal event or situation that caused voltages on utility, municipal or customer-owned devices to exceed the above thresholds. (Note that NCI will adopt a different term or definition for stray voltage in its final report to the DTE.)

NCI is submitting this data confirmation request to all utilities. Accordingly, the term "utility" or "company" shall refer to the utility receiving this request. Subsequent

information requests may be issued following the receipt of utility responses to this initial request.

Please provide responses 10 days following receipt of this request. Accordingly, for those requests that will require more than 10 days, please indicate when responses will be provided.

NOTE: The information requests issued to each utility are separately attached as these requests varied by company.

NSTAR

1. Please confirm that the following list of equipment and locations inspected for stray voltage in 2004 is accurate. If the list is inaccurate, please update the list, and provide an explanation if your company believes the list is materially inaccurate. Also, please provide any additional stray voltage inspection or detection information collected during 2005.

Company	Number and Type of Facilities Inspected	Number of Facilites with Stray Voltage Detected
NSTAR	42,869 manhole locations	33

2. Please confirm that each instance where stray voltage has been detected as a result of the inspections and measurement undertaken in 2004 and 2005 (year-to-date) has been corrected. For purposes of this data confirmation request, correction of stray voltage includes, but is not limited to equipment replacement, repairs, modifications and reconfiguration necessary to bring the voltage to a level your company deems to be safe to utility workers, the general public and domestic animals. If any have not been corrected, please provide an explanation why remediation was deemed unnecessary. If a third-party or other utility is responsible for correcting the detected stray voltage, please indicate to the best of your knowledge the status of remediation efforts at these locations.

3. Does your company agree or disagree that the following equipment is susceptible to stray voltage? If your company disagrees with the list, please itemize and provide a brief explanation as to why the equipment is not susceptible to stray voltage. Also, for the equipment listed that your company agrees is susceptible to stray voltage, please indicate whether the equipment will be inspected and tested in 2006 and later years.

- Secondary cables (120 volts to 600 volts)
- Padmount transformers or equipment enclosures
- Street light poles
- Metal risers
- Secondary pedestals and service boxes
- Guy Wires
- Manhole covers
- Control equipment enclosures

4. Please confirm the following costs for stray voltage inspections conducted during 2004. If these costs are inaccurate, please update. Also, please provide any additional costs for stray voltage inspection costs conducted during 2005.

Inspection Cost	Total Distribution Expense Budget	Percent of Total Dist. Expense Budget	Distribution Maintenance Budget	Percent of Maintenance Budget
$ 642,467	$ 105,322,537	0.61%	$ 35,069,067	2.00%

5. Please confirm that your company does not plan to prospectively itemize the cost of stray voltage detection or remediation in future years' budgets. If your company proposes an alternate method to track stray voltage detection and remediation costs, please describe the system or processes it proposes to employ.

6. Does your company agree or disagree with the following statement:

7. *There is no direct evidence that the total number of stray voltage events has increased since March 1, 1998. However, there appears to be anecdotal evidence and records based on recent events in Massachusetts and other states to suggest the number of <u>hazardous</u> events has increased.*

8. If your company wholly or in part disagrees with the statement, please provide the basis or data sources to support an alternate conclusion or explanation.

9. Please confirm the following summary of the Company's future stray voltage detection, testing and remediation plans.

10. Perform voltage indication testing on all electrical infrastructure located in the Company's service territory on a 3-year rolling basis.

11. Resolve "issues relating to retired or removed streetlights fed by the underground electric system and removed or abandoned service cables associated with demolished buildings." Please describe the results of this program as of the date of issuance of this data confirmation request, and proposed activities in 2006 (and subsequent years, if applicable). Please include a list of facilities where stray voltage has been detected on facilities accessible by the public or domestic animals.

12. Implement all recommendations included in the 2005 Joint Task Force report, including those cited in (a) and (b) above.

13. Does your company agree or disagree with the use of a 20-volt threshold as a minimum standard for stray voltage detection and measurement? Does your company agree or disagree that humans may not always be able to detach from the sources energized at 20 volts or higher? Please state whether all measurement devices the Company has or proposes to use to detect stray voltage are rated to detect voltages to 20 volts or higher.

14. Does your company agree or disagree that the number of stray voltage events or potential of stray voltage conditions increases during winter months; for example, due to reduced ground path resistance caused by the presence of contaminants and/or increased moisture.

15. Please confirm that the company's facility management system and records do not or are unable to produce a list that itemizes secondary equipment and services according to equipment vintage, manufacturer, and condition, by location, nor does it plan to convert the system in the near future (i.e., next 2-3 years) to include such detailed records. If your company disagrees with the statement, please describe which records are available in the detail described or if the company proposes to convert such records in the future, the expected date of completion for the conversion.

16. Please confirm that, except for failures, your company does not currently nor does it propose to include the scheduled replacement of radial and network secondary equipment and services in its capital budgets. (Secondary equipment is defined to include, at minimum, lines and cables rated 600 volts or less, transformers, pad-mound switchgear, pedestals, conduits, manholes, vaults and handholes.) If your company agrees with the prior statement, does your company agree or disagree with the premise that the number of stray events will likely increase over time due to increased wear and deterioration on existing

secondary equipment and services (i.e., equipment rated to operate at 600 volts or less)?

Supplemental Information Requests

17. Please provide an update of the Company's "2005 Stray Voltage Work Plan," including the 15 recommendations from the Mayor's Joint Task Force. Please include number of devices or locations inspected, the number of stray voltage events detected, remediation activities and other aspects of the Plan relevant to the DTE's investigation of stray voltage of the Massachusetts electric utilities.

18. Please provide a sample copy or page from the Company's Trouble Management System that illustrates, by example, the type of information recorded for a stray voltage event that has been assigned an "area energized" tag.

19. Referring to the Company's prior response to Question 13 of NCI's Data Request No. 1, please indicate the circumstances under which the Company studies both the normal and contingency outage state of secondary system and system components in those areas to identify maintenance and capital projects that are needed to maintain and improve the integrity of the underground distribution system, including how it prioritizes secondary or other low voltage system upgrades.

20. Referring to Joint Task Force Report and Question 7a, please provide a descriptive list of the equipment or facilities where the Company proposes to "perform voltage-indication testing on all electrical infrastructure owned or maintained by NSTAR Electric on a three-year rolling basis." Also, will the voltage indication testing include facilities the Company owns or maintains throughout the entire NSTAR service territory?

National Grid

1. Please confirm that the following list of equipment and locations inspected for stray voltage in 2004 is accurate. If the list is inaccurate, please update the list, and provide an explanation if your company believes the list is materially inaccurate. Also, please provide any additional stray voltage inspection or detection information collected during 2005.

Number and Type of Facilities Inspected	Number of Facilites with Stray Voltage Detected
18,361 pole locations	127

2. Please confirm that each instance where stray voltage has been detected as a result of the inspections and measurement undertaken in 2004 and 2005 (year-to-date) has been corrected. For purposes of this data confirmation request, correction of stray voltage includes, but is not limited to equipment replacement, repairs, modifications and reconfiguration necessary to bring the voltage to a level your company deems to be safe to utility workers, the general public and domestic animals. If any have not been corrected, please provide an explanation why remediation was deemed unnecessary. If a third-party or other utility is responsible for correcting the detected stray voltage, please indicate to the best of your knowledge the status of these locations.

3. Does your company agree or disagree that the following equipment is susceptible to stray voltage? If your company disagrees with the list, please itemize and provide a brief explanation as to why the equipment is not susceptible to stray voltage. Also, for the equipment listed that your company agrees is susceptible to stray voltage, please indicate whether the equipment will be inspected and tested in 2006 and later years.

    - Secondary cables (120 volts to 600 volts)
    - Padmount transformers or equipment enclosures
    - Street light poles
    - Metal risers
    - Secondary pedestals and service boxes
    - Guy Wires
    - Manhole covers
    - Control equipment enclosures

4. Please confirm the following costs for stray voltage inspections conducted during 2004. If these costs are inaccurate, please update. Also, please provide any additional costs for stray voltage inspection costs conducted during 2005.

Inspection Cost	Total Distribution Expense Budget	Percent of Total Dist. Expense Budget	Distribution Maintenance Budget	Percent of Maintenance Budget
$ 263,000	$ 94,758,000	0.28%	$ 38,278,000	0.69%

5. Also, does your company agree that it plans to spend approximately $1 million in 2005, and on average, approximately $500,000 annually over the next four years for inspection and testing? If yes, please confirm year-to-date expenditures for 2005 and the results of the inspection and testing performed in 2005 (if not addressed elsewhere in this request).

6. Does your company agree or disagree with the following statement:

7. *There is no direct evidence that the total number of stray voltage events has increased since March 1, 1998. However, there appears to be anecdotal evidence and records based on recent events in Massachusetts and other states to suggest the number of <u>hazardous</u> events has increased.*

8. If your company wholly or in part disagrees with the statement, please provide the basis or data sources to support an alternate conclusion or explanation.

9. Please confirm the following summary of the Company's future stray voltage detection, testing and remediation plans.

10. Retest 25 percent of street lights in 2005 and all street lights in next 12 months (as of July 2005)

11. 100 percent inspection of all distribution poles (over 1 million) and testing of all publicly accessible equipment in the next three years.

12. 100 percent inspection of all padmounted equipment on a rolling 5-year basis. Please list types of padmounted equipment and other facilities the Company expects to test during the inspections.

13. Does your company agree or disagree with the use of a 20-volt threshold as a minimum standard for stray voltage detection and measurement? Does your company agree or disagree that humans may not always be able to detach from the sources energized at 20 volts or higher? Please state whether all measurement devices the Company has or proposes to use to detect stray voltage are rated to detect voltages to 20 volts or higher.

14. Does your company agree or disagree that the number of stray voltage events or potential of stray voltage conditions increases during winter months; for example, due to reduced ground path resistance caused by the presence of contaminants and/or increased moisture.

15. Please confirm that the company's facility management system and records do not or are unable to produce a list that itemizes secondary equipment and services according to equipment vintage, manufacturer, and condition, by location, nor does it plan to convert the system in the near future (i.e., next 2-3 years) to include such detailed records. If your company disagrees with the statement, please describe which records are available in the detail described or if the company proposes to convert such records in the future, the expected date of completion for the conversion.

16. Please confirm that, except for failures, your company does not currently nor does it propose to include the scheduled replacement of radial and network secondary equipment and services in its capital budgets. (Secondary equipment is defined to include, at minimum, lines and cables rated 600 volts or less, transformers, pad-mound switchgear, pedestals, conduits, manholes, vaults and handholes.) If your company agrees with the prior statement, does your company agree or disagree with the premise that the number of stray events will likely increase over time due to increased wear and deterioration on existing secondary equipment and services (i.e., equipment rated to operate at 600 volts or less)?

WMECO (NU)

1. Please confirm that the following list of equipment and locations inspected for stray voltage in 2004 is accurate. If the list is inaccurate, please update the list, and provide an explanation if your company believes the list is materially inaccurate. Also, please provide any additional stray voltage inspection or detection information collected during 2005.

Company	Number and Type of Facilities Inspected	Number of Facilites with Stray Voltage Detected
WMECO	3,243 metal street lights	4

2. Please confirm that each instance where stray voltage has been detected as a result of the inspections and measurement undertaken in 2004 and 2005 (year-to-date) has been corrected. For purposes of this data confirmation request, correction of stray voltage includes, but is not limited to equipment replacement, repairs, modifications and reconfiguration necessary to bring the voltage to a level your company deems to be safe to utility workers, the general public and domestic animals. If any have not been corrected, please provide an explanation why remediation was deemed unnecessary. If a third-party or other utility is responsible for correcting the detected stray voltage, please indicate to the best of your knowledge the status of remediation efforts at these locations.

3. Does your company agree or disagree that the following equipment is susceptible to stray voltage? If your company disagrees with the list, please itemize and provide a brief explanation as to why the equipment is not susceptible to stray voltage. Also, for the equipment listed that your company agrees is susceptible to stray voltage, please indicate whether the equipment will be inspected and tested in 2006 and later years.

    - Secondary cables (120 volts to 600 volts)
    - Padmount transformers or equipment enclosures
    - Street light poles
    - Metal risers
    - Secondary pedestals and service boxes
    - Guy Wires
    - Manhole covers
    - Control equipment enclosures

4. Please confirm the following costs for stray voltage inspections conducted during 2004. If these costs are inaccurate, please update. Also, please provide any additional costs for stray voltage inspection costs conducted during 2005.

Inspection Cost	Total Distribution Expense Budget	Percent of Total Dist. Expense Budget	Distribution Maintenance Budget	Percent of Maintenance Budget
$ 42,500	$ 19,923,334	0.21%	$ 13,997,899	0.30%

5. Please confirm that your company does not plan to prospectively itemize the cost of stray voltage detection or remediation in future years' budgets. If your company proposes an alternate method to track stray voltage detection and remediation costs, please describe the system or processes it proposes to employ.

6. Does your company agree or disagree with the following statement:

7. *There is no direct evidence that the total number of stray voltage events has increased since March 1, 1998. However, there appears to be anecdotal evidence and records based on recent events in Massachusetts and other states to suggest the number of <u>hazardous</u> events has increased.*

8. If your company wholly or in part disagrees with the statement, please provide the basis or data sources to support an alternate conclusion or explanation.

9. Please confirm the Company does not plan to implement a formal program to systematically test for stray voltage on <u>existing</u> facilities (i.e., in addition to inspections performed in 2004 and 2005).

10. Does your company agree or disagree with the use of a 20-volt threshold as a minimum standard for stray voltage detection and measurement? Does your company agree or disagree that humans may not always be able to detach from the sources energized at 20 volts or higher? Please state whether all measurement devices the Company has or proposes to use to detect stray voltage are rated to detect voltages to 20 volts or higher.

11. Does your company agree or disagree that the number of stray voltage events or potential of stray voltage conditions increases during winter months; for example, due to reduced ground path resistance caused by the presence of contaminants and/or increased moisture.

12. Please confirm that the company's facility management system and records do not or are unable to produce a list that itemizes secondary equipment and services according to equipment vintage, manufacturer, and condition, by location, nor does it plan to convert the system in the near future (i.e., next 2-3 years) to include such detailed records. If your company disagrees with the statement, please describe which records are available in the detail described or if the company proposes to convert such records in the future, the expected date of completion for the conversion.

13. Please confirm that, except for failures, your company does not currently nor does it propose to include the scheduled replacement of radial and network secondary equipment and services in its capital budgets. (Secondary equipment is defined to include, at minimum, lines and cables rated 600 volts or less, transformers, pad-mound switchgear, pedestals, conduits, manholes, vaults and handholes.) If your company agrees with the prior statement, does your company agree or disagree with the premise that the number of stray events will likely increase over time due to increased wear and deterioration on existing secondary equipment and services (i.e., equipment rated to operate at 600 volts or less)?

UNITIL (FG&E)

1. Please confirm that the Company has not detected any instances of stray voltage as of the date of this request. Where applicable, please provide any additional stray voltage inspection or detection information collected during 2005.

2. If any instances of stray voltage has been detected since NCI first data request, lease confirm that each instance where stray voltage has been detected as a result of the inspections and measurement undertaken in 2004 and 2005 (year-to-date) has been corrected. For purposes of this data confirmation request, correction of stray voltage includes, but is not limited to equipment replacement, repairs, modifications and reconfiguration necessary to bring the voltage to a level your company deems to be safe to utility workers, the general public and domestic animals. If any have not been corrected, please provide an explanation why remediation was deemed unnecessary. If a third-party or other utility is responsible for correcting the detected stray voltage, please indicate to the best of your knowledge the status of remediation efforts at these locations.

3. Does your company agree or disagree that the following equipment is susceptible to stray voltage? If your company disagrees with the list, please itemize and provide a brief explanation as to why the equipment is not susceptible to stray voltage. Also, for the equipment listed that your company agrees is susceptible to stray voltage, please indicate whether the equipment will be inspected and tested in 2006 and later years.

   - Secondary cables (120 volts to 600 volts)
   - Padmount transformers or equipment enclosures
   - Street light poles
   - Metal risers
   - Secondary pedestals and service boxes
   - Guy Wires
   - Manhole covers
   - Control equipment enclosures

4. Please confirm the Company did not itemize or estimate the cost of stray voltage inspections performed in 2004 or 2005 (year-to-date).

5. Please confirm that your company does not plan to prospectively itemize the cost of stray voltage detection or remediation in future years' budgets. If your company proposes an alternate method to track stray voltage detection and remediation costs, please describe the system or processes it proposes to employ.

6. Does your company agree or disagree with the following statement:

   There is no direct evidence that the total number of stray voltage events has increased since March 1, 1998. However, there appears to be anecdotal evidence and records based on recent events in Massachusetts and other states that suggest the number of <u>hazardous</u> events has increased.

7. If your company wholly or in part disagrees with the statement, please provide the basis or data sources to support an alternate conclusion or explanation.

8. Please confirm the Company's standard or practice regarding stray voltage testing will include the following:

a. Annual testing for manholes. Please describe the specific facilities that will be tested, including adjacent facilities and other equipment susceptible to stray voltage.
b. Five-year rolling test for stray voltage on other equipment accessible to the public or domestic animals (i.e., the Company will test other equipment for stray voltage as part of the routine inspections.). Please itemize the list of equipment to be tested if your company agrees with this statement.

9. Does your company agree or disagree with the use of a 20-volt threshold as a minimum standard for stray voltage detection and measurement? Does your company agree or disagree that humans may not always be able to detach from the sources energized at 20 volts or higher? Please state whether all measurement devices the Company has or proposes to use to detect stray voltage are rated to detect voltages to 20 volts or higher.

10. Does your company agree or disagree that the number of stray voltage events or potential of stray voltage conditions increases during winter months; for example, due to reduced ground path resistance caused by the presence of contaminants and/or increased moisture.

11. Please confirm that the company's facility management system and records do not or are unable to produce a complete list that itemizes secondary equipment and services according to equipment vintage, manufacturer, and condition, by location... If your company disagrees with the statement, please describe which records are available in the detail described or if the company proposes to convert such records in the future, the expected date of completion for the conversion.

12. Please confirm that, except for failures, your company does not currently nor does it propose to include the scheduled replacement of radial and network secondary equipment and services in its capital budgets. (Secondary equipment is defined to include, at minimum, lines and cables rated 600 volts or less, transformers, pad-mound switchgear, pedestals, conduits, manholes, vaults and handholes.) If your company agrees with the prior statement, does your company agree or disagree with the premise that the number of stray events will likely increase over time due to increased wear and deterioration on existing secondary equipment and services (i.e., equipment rated to operate at 600 volts or less)?